The listing of Claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) A computer implemented method of interpolating pixel data in scaling pixel data for display, the method comprising:

determining a pixel value at an interpolation location of a display based on filtering originally formatted input pixel data surrounding the interpolation location in a plurality of directions from the interpolation location, wherein determining a pixel value comprises:

low-pass filtering the data surrounding the interpolation location using Lagrangian filtering to determine a direction of interpolation for the interpolation location;

calculating pixel data values at points where a line, that passes through the interpolation location and extending in the direction of interpolation, intersects horizontal or vertical lines of the display, wherein the points are not included in the originally formatted input pixel data;

filtering the pixel data values at the points, using Lagrangian filtering, to provide an interpolated pixel value at the location of interpolation; and

providing the interpolated pixel value to the display to provide a scaled-up image thereon compared to the originally formatted input pixel data.

2. (Currently Amended) A computer implemented method according to Claim 1 wherein the plurality of directions comprises more than two different directions.

3. (Currently Amended) A computer implemented method according to Claim 1 wherein the plurality of directions comprises seven different directions.

4. (Currently Amended) A computer implemented method according to Claim 1 wherein determining comprises:

low-pass filtering the data surrounding the interpolation location to determine a direction of interpolation at the interpolation location;

filtering the direction of interpolation to determine pixel data values at points on a line that intersects horizontal or vertical lines of the display; and

filtering the pixel data values at the points to provide an interpolated pixel value at the location of interpolation.

5. (Currently Amended) A computer implemented method according to Claim 4 wherein filtering the direction of interpolation comprises applying ~~Lagrangian or~~ polyphase filtering to the direction of interpolation.

6. (Currently Amended) A computer implemented method according to Claim 4 wherein filtering the pixel data values comprises applying ~~Lagrangian or~~ polyphase filtering to the direction of interpolation.

7. (Currently Amended) A computer implemented method according to Claim 4 wherein low-pass filtering comprises weighting pixel values of the data surrounding the interpolation location differently based on different spatial relations between a location of the pixel value and the interpolation location.

8. (Currently Amended) A scaling interpolation apparatus comprising:

a direction determination unit, which receives and LPF (low-pass filter) filters originally formatted pixel data on a plurality of lines passing through an interpolation location and determines a direction value, which is used for a direction of interpolation at the interpolation location from the LPF-filtered data, and outputs the direction value; and

a directional interpolator, which calculates pixel data values using Lagrangian filtering, at points where a line that passes through the interpolation location and extending in the direction of interpolation intersects horizontal or vertical lines of the display, using Lagrangian ~~or polyphase~~ filtering wherein the points are not included in the originally formatted input pixel data, applies Lagrangian or polyphase filtering to the calculated pixel data on the extended line, and obtains and outputs interpolation data of

the interpolation location to provide an interpolated pixel value to a display to provide a scaled-up image thereon compared to the originally formatted input pixel data.

9. (Currently Amended) An apparatus that scales a digital image signal comprising:

a memory unit, which receives originally formatted input pixel data, updates and stores the pixel data on a plurality of lines passing through an interpolation location, and outputs the updated pixel data in response to a control signal;

a scaling interpolator, which determines a direction of interpolation of the interpolation location from LPF-filtered data of the updated pixel data in response to the control signal, calculates pixel data values at points where an extended line that passes through the interpolation location and extending in the direction of interpolation intersects horizontal or vertical lines of the display using Lagrangian or polyphase filtering wherein the points are not included in the originally formatted input pixel data, applies Lagrangian ~~or polyphase~~ filtering to the calculated pixel data on the extended line, and obtains and outputs interpolation data of the interpolation location to provide an interpolated pixel value to a display to provide a scaled-up image thereon compared to the originally formatted input pixel data ; and

a controller which generates the control signal, which controls the LPF-filtering, and the Lagrangian filtering or polyphase filtering.

10. (Currently Amended) The apparatus of claim 9, wherein the scaling interpolator comprises:

a direction determination unit, which LPF-filters the updated pixel data in response to the control signal, determines the direction value which corresponds to the direction of interpolation of the interpolation location from the LPF-filtered data, and outputs the direction value; and

a directional interpolator, which calculates the pixel data values of the intersections of the horizontal (or vertical) lines and the extended line using Lagrangain ~~or polyphase filtering~~ in response to the control signal, applies Lagrangian filtering ~~or~~

~~polyphase filtering~~ to the calculated pixel data, and obtains and outputs the interpolation data of the interpolation location.

11. (Original) The apparatus of claim 10, wherein the LPF filtering is performed by an LPF with the property:

$$x'(i,j)=\frac{x(i-1,j)+6\times x(i,j)+x(i+1,j)}{8},$$

wherein x'(i, j) is the filtered data and x(i, j) is pixel data at the i-th row and j-th column.

12. (Original) The apparatus of claim 10, wherein the direction of interpolation is determined by a direction value that is linearly changed between a direction value of a pixel P1 above (or to the left of) the interpolation location and a direction value of a pixel P2 below (or to the right of) the interpolation location according to the interpolation location, if the direction values of two pixels P1 and P2 above and below the interpolation location are each represented by seven values of 1 through 7.

13. (Original) The apparatus of claim 12, wherein the direction value of the pixel is determined by:

$$If\left|W_{dir_{GLOBAL}}\cdot Pe_{dir_{GLOBAL}}-W_{dir_{LOCAL}}\cdot Pe_{dir_{LOCAL}}\right|<T$$

$$DIR_i=DIR_{LOCAL},$$

$$else$$

$$DIR_i=DIR_{GLOBAL},$$

where, $Pe_{dir}=\sum_{k=0}^{n-1}a\left|x'_p(i,j:k)-x'(i,j)\right|$ is used to calculate a difference between the LPF-filtered data and the updated pixel data, $W_{dir}=\begin{cases}1.0 & dir=1\\ 1.25 & dir=2,3\\ 1.375 & dir=4,5\\ 1.5 & dir=6,7\end{cases}$ is used for calculating a weighted value, and $DIR_{LOCAL}=\underset{dir}{ARG}\left\{\min_{1\le dir\le 3}(W_{dir}\times Pe_{dir})\right\}$ and

$DIR_{GLOBAL} = \underset{dir}{ARG}\left\{\min_{1\le dir\le 7}(W_{dir} \times Pe_{dir})\right\}$ are used to calculate the direction value according to the minimal value of W_{dir} x Pe_{dir};

wherein, k is a reference index representing one of five pairs of pixels, x'(i, j) is the LPF-filtered pixel data, $x'_p(i, j:k)$ is the average value of the pixel data corresponding to the reference index k for data situated about the reference pixel in each of the seven directions, a is a weighted value according to k, wherein a=2 if k is the value corresponding to the pair centered around the reference pixel, and a=1 otherwise, DIR_{LOCAL} is a local direction value, DIR_{GLOBAL} is a global direction value, DIR_i is a final direction value, and T is a constant representing a threshold value that depends on an image noise.

14. (Original) The apparatus of claim 10, wherein the Lagrangian or the polyphase filtering is performed by a Lagrangian filter or a polyphase filter using:

$$L_i(t) = \prod_{k=0,k\neq i}^{n} \frac{t-k}{i-k} \text{ and}$$

$$p_n(t) = \sum_{i=0}^{n} L_i(i)x(i),$$

wherein n is the number of pixels to be used for interpolation, t is a distance from the first pixel of the n pixels to the intersection location, and x(i) is pixel data at the respective intersections.

15. (Currently Amended) A scaling interpolation computer implemented method comprising:

receiving and LPF-filtering originally formatted pixel data on a plurality of lines passing through an interpolation location and determining a direction value, which is used for a direction of interpolation at the interpolation location from the LPF-filtered data and outputting the direction value;

calculating pixel data values at points where an extended line that passes through the interpolation location and extending in the direction of interpolation intersects

horizontal or vertical lines of the display using Lagrangian or polyphase filtering wherein the points are not included in the originally formatted pixel data;

applying Lagrangian ~~or polyphase~~ filtering to the calculated pixel data on the extended line; and

obtaining and outputting interpolation data of the interpolation location to provide an interpolated pixel value to a display to provide a scaled-up image thereon compared to the originally formatted input pixel data.

16. (Currently Amended) A method of scaling a digital image signal, comprising:

(a) receiving originally formatted input pixel data, updating and storing pixel data on a plurality of lines passing through an interpolation location, and outputting the updated pixel data in response to a control signal;

(b) determining a direction of interpolation of the interpolation location from LPF-filtered data of the updated pixel data in response to the control signal, calculating pixel data values at points where an extended line that passes through the interpolation location and extending in the direction of interpolation intersects horizontal or vertical lines of the display using Lagrangian ~~or polyphase~~ filtering wherein the points are not included in the originally formatted pixel data, applying Lagrangian or polyphase filtering to the calculated pixel data on the extended line, and obtaining and outputting interpolation data of the interpolation location to provide an interpolated pixel value to a display to provide a scaled-up image thereon compared to the originally formatted input pixel data; and

(c) generating the control signal, which controls the LPF filtering, and the Lagrangian filtering or polyphase filtering.

17. (Original) The method of claim 16, wherein step (b) further comprises:

(b-1) LPF-filtering the updated pixel data in response to the control signal and determining the direction value, which corresponds to the direction of interpolation of the interpolation location from the LPF-filtered data, and outputting the direction value; and

(b-2) calculating the pixel data of the intersections of the horizontal (or vertical) lines and the extended line corresponding to the direction value using Lagrangian or polyphase filtering in response to the control signal, applying Lagrangian or polyphase filtering to the calculated pixel data, and obtaining and outputting the interpolation data of the interpolation location.

18. (Original) The method of claim 15 wherein the LPF filtering is performed by an LPF with the property:

$$x'(i,j)=\frac{x(i-1,j)+6\times x(i,j)+x(i+1,j)}{8},$$

wherein x'(i, j) is the filtered data and x(i, j) is pixel data at the i-th row and j-th column.

19. (Original) The method of claim 15 wherein the direction of interpolation is determined by a direction value that is linearly changed between a direction value of a pixel P1 above (or to the left of) the interpolation location and a direction value of a pixel P2 below (or to the right of) the interpolation location according to the interpolation location, if the direction values of the two pixels P1 and P2 above and below the interpolation location are each represented by seven values of 1 through 7.

20. (Original) The method of claim 19 wherein the direction value of the pixel is determined by:

$$If \left| W_{dir_{GLOBAL}} \cdot Pe_{dir_{GLOBAL}} - W_{dir_{LOCAL}} \cdot Pe_{dir_{LOCAL}} \right| < T$$

$$DIR_i = DIR_{LOCAL},$$

$$else$$

$$DIR_i = DIR_{GLOBAL},$$

where, $Pe_{dir} = \sum_{k=0}^{n-1} a\left|x'_p(i,j:k) - x'(i,j)\right|$ is used to calculate a difference between the LPF-filtered data and the updated pixel data, $W_{dir} = \begin{cases} 1.0 & dir = 1 \\ 1.25 & dir = 2,3 \\ 1.375 & dir = 4,5 \\ 1.5 & dir = 6,7 \end{cases}$ is used for calculating a weighted value, and $DIR_{LOCAL} = \underset{dir}{ARG}\left\{\min_{1 \le dir \le 3}(W_{dir} \times Pe_{dir})\right\}$ and $DIR_{GLOBAL} = \underset{dir}{ARG}\left\{\min_{1 \le dir \le 7}(W_{dir} \times Pe_{dir})\right\}$ are used to calculate the direction value according to the minimal value of W_{dir} x Pe_{dir};

wherein, k is a reference index representing one of five pairs of pixels, x'(i, j) is the LPF-filtered pixel data, $x'_p(i, j:k)$ is the average value of the pixel data corresponding to the reference index k for data situated about the reference pixel in each of the seven directions, a is a weighted value according to k, wherein a=2 if k is the value corresponding to the pair centered around the reference pixel, and a=1 otherwise, DIR_{LOCAL} is a local direction value, DIR_{GLOBAL} is a global direction value, DIR_i is a final direction value, and T is a constant representing a threshold value that depends on an image noise.

21. (Original) The method of claim 15, wherein the Lagrangian or the polyphase filtering is performed by a Lagrangian filter or a polyphase filter using:

$$L_i(t) = \prod_{k=0, k \neq i}^{n} \frac{t-k}{i-k} \text{ and}$$

$$p_n(t) = \sum_{i=0}^{n} L_i(i)x(i),$$

wherein n is the number of pixels to be used for interpolation, t is a distance from the first pixel of the n pixels to the intersection location, and x(i) is pixel data at the respective intersections.

22. (Currently Amended) A computer program product for interpolating pixel data in scaling pixel data for display, comprising:

a computer readable medium having computer readable program code embodied therein, the computer readable program product comprising:

computer readable program code configured to determine a pixel value at an interpolation location of a display based on filtering originally formatted pixel data surrounding the interpolation location in a plurality of directions from the interpolation location, wherein the computer readable program code configured to determine a pixel value comprises:

computer readable program code configured to low-pass filter the data surrounding the interpolation location to determine a direction of interpolation for the interpolation location;

computer readable program code configured to calculate pixel data values at points where a line that passes through the interpolation location and extending in the direction of interpolation intersects horizontal or vertical lines of the display wherein the points are not included in the originally formatted pixel data ; and

computer readable program code configured to filter the pixel data values using Lagrangian filtering at the points to provide an interpolated pixel value at the location of interpolation.

23. (Original) A computer program product according to Claim 22 wherein the plurality of directions comprises more than two different directions.

24. (Previously Presented) A computer program product according to Claim 22 wherein the plurality of directions comprises seven different directions.

25. (Previously Presented) A computer program product according to Claim 22 wherein the computer readable program code configured to determine comprises:

computer readable program code configured to low-pass filter the data surrounding the interpolation location to determine a direction of interpolation at the interpolation location;

computer readable program code configured to filter the direction of interpolation to determine pixel data values at points on a line that intersects horizontal or vertical lines of the display; and

computer readable program code configured to filter the pixel data values at the points to provide an interpolated pixel value at the location of interpolation to provide an interpolated pixel value to a display to provide a scaled-up image thereon compared to the originally formatted input pixel data.

26. (Original) A computer program product according to Claim 25 wherein the computer readable program code configured to filter the direction of interpolation comprises computer readable program code configured to apply Lagrangian or polyphase filtering to the direction of interpolation.

27. (Original) A computer program product according to Claim 25 wherein the computer readable program code configured to filter the pixel data values comprises computer readable program code configured to apply Lagrangian or polyphase filtering to the direction of interpolation.

28. (Previously Presented) A computer program product according to Claim 25 wherein the computer readable program code configured to low-pass filter comprises computer readable program code configured to weight pixel values of the data surrounding the interpolation location differently based on different spatial relations between a location of the pixel value and the interpolation location.